BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

COPY

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this office.

Date of Application: February 3, 1988

Application Number: Patent Application Number: 63-24193

Applicant(s): Kanzaki Kokyukoki Manufacturing Co., Ltd.

February 15, 1989

Fumitake YOSHIDA
Commissioner, Patent Office

Verification No. 64-275

COPY

International Patent Classification	
Subclass	Group
B 60 K	17/00

Patent Application (1)

(¥ 14,000) February 3, 1988

To the Honorable Kunio OGAWA, Commissioner of the Japanese Patent Office

1. Title of the Invention: Axle Driving Apparatus

2. Number of Claims: 3

3. Inventor
   - Name: Hideaki OKADA (and no other)
   - Address: Kanzaki Kokyukoki Manufacturing Co., Ltd.
     2-18-1, Inadera, Amagasaki, Hyogo-ken

4. Applicant
   - Name: Kanzaki Kokyukoki Manufacturing Co., Ltd.
   - Address: 2-18-1, Inadera, Amagasaki, Hyogo-ken
   - Representative: Kojiro YAMAOKA (and no other)

5. Agent
   - Name: (8062) Juichiro YANO, Patent Attorney [seal affixed]
   - Address: Nagahori Yachiyo Building
     1-11-9, Minami-Funaba, Minami-ku, Osaka
     Tel. 06-261-3047

6. Record of Items Submitted

(1)	Specification	1 copy
(2)	Drawings	1 copy
(3)	Duplicate Copy of Application	1 copy
(4)	Power of Attorney	1 copy

Specification

1. Title of the Invention

Axle Driving Apparatus

2. Claims

(1). An axle driving apparatus characterized in that an axle 13 is journalled between an upper half casing 1 and a lower half casing 2 divided above and below horizontally, an HST transmission device for driving said axle 13 disposed inside the case formed by joining together the upper half casing 1 and the lower half casing 2, the oil passage plate 3 connecting both oil passages being fixed to the mounting surface of the upper half casing 1 between the hydraulic pump P and the hydraulic motor M composing said HST transmission device.

(2). An axle driving apparatus according to Claim 1, wherein the motor shaft 5 of the hydraulic motor M is disposed parallel to the axle 13, said motor shaft 5 being journalled in the joined surface of the upper half casing 1 and the lower half casing 2, wherein the pump shaft 4 of the hydraulic pump P is disposed vertically, wherein the contact surfaces of the hydraulic pump P and the hydraulic motor M are disposed orthogonally to the oil passage plate 3, and wherein the pump mounting surface 3d is the same as the mounting surface for the oil passage plate 3 on the upper half casing 1.

(3). An axle driving apparatus according to Claim 1 and Claim 2, wherein two oil passages 3a · 3b connecting the hydraulic pump P to the hydraulic motor M are formed

in the oil passage plate 3, wherein two check valves 26 · 27 for supplying operating oil in the direction of said oil passages are disposed between the two oil passages 3a · 3b, wherein an operating oil intake port 3c extending downward is opened between said check valves 26 · 27, and wherein an oil filter 8 is attached to the bottom of said oil passage plate 3.

3. Detailed Description of the Invention

(a) Industrial Field of Application

The invention relates to an HST axle driving apparatus used as the propulsion device for a tractor.

(b) Prior Art

In an axle driving apparatus well known in the art, the casing for the axle driving apparatus is divided above and below, the axles are journalled in the divided surface, and the axles are powered by an HST transmission device attached to the casing.

An example submitted by the present applicant was disclosed in Japanese Utility Model Publication No. 62-44198.

(c) Problems Solved by the Invention

In the prior art, the HST transmission device is completely separate from the axle drive apparatus. It is supported in an exposed manner on the outside of the casing for the axle drive apparatus. As a result, the overall unit is large and heavy. In order to drive axles situated horizontally using the motor shaft on a hydraulic motor situated vertically, a bevel gear device has to be interposed between both drive systems.

Also, a reserve tank is needed to supply operating oil to the HST transmission device. In order to use the lubricating oil inside the drive casing as operating oil, a pipe and oil passage are needed between the drive casing and the HST transmission device. This configuration is cumbersome.

To solve the problems associated with the prior art, the hydraulic motor M and the hydraulic pump P in the HST transmission device are situated inside the axle drive apparatus of the invention, an oil passage plate 3 communicating with the hydraulic motor M and the hydraulic pump P is also situated inside, and the oil passage plate is fixed to the joined surface.

By bending the oil passage from the hydraulic pump P to the hydraulic motor M in the oil passage plate 3 and situating the motor shaft in the same direction as the axles, the transmission direction can be changed using the oil passages inside the oil passage plate instead of using bevel gears to change the rotational direction as in the case of the prior art.

(d) Means of Solving the Problem

The following is an explanation of the configuration of the invention used to achieve the purpose described above.

The axle driving apparatus of the invention is characterized in that an axle 13 is journalled between an upper half casing 1 and a lower half casing 2 divided above and below horizontally, an HST transmission device for driving the axle 13 disposed inside the case formed by joining together the upper half casing 1 and the lower half casing 2, the oil passage plate 3 connecting both oil passages being fixed to the mounting surface of the upper half casing 1 between the hydraulic pump P and the hydraulic motor M composing the HST transmission device.

As shown in an embodiment of the invention, the motor shaft 5 of the hydraulic motor M is disposed parallel to the axle 13, the motor shaft 5 journalled in the joined surface of the upper half casing 1 and the lower half casing 2, and the pump shaft 4 of the hydraulic pump P is disposed vertically, the contact surfaces of the hydraulic pump P and the hydraulic motor M are disposed perpendicular to the oil passage plate 3, and the pump mounting surface 3d is the same as the mounting surface for the oil passage plate 3 on the upper half casing 1.

As shown in another embodiment of the invention, two oil passages 3a · 3b connecting the hydraulic pump P to the hydraulic motor M are formed in the oil passage plate 3, two check valves 26 · 27 for supplying operating oil in the direction of the oil passages are disposed between the two oil passages 3a · 3b, an operating oil intake port 3c opened to below is opened between the check valves 26 · 27, and an oil filter 8 is attached to the bottom of the oil passage plate 3.

(e) Working Examples

The purpose · configuration of the invention described above will now be explained with reference to the working examples shown in the drawings.

FIG 1 is a side view of a light tractor provided with an axle driving apparatus of the invention. FIG 2 is a sectional rear view of the axle driving apparatus of the invention. FIG 3 is a sectional view taken from the line I-I in FIG 2 showing the state where the upper half casing is removed from the embodiment in FIG 1. FIG 4 is a plan view taken from the line II-II in FIG 2. FIG 5 and FIG 6 are perspective views of other configurations for the oil passage plate 3.

FIG 1 shows a light tractor containing an engine E equipped with a vertical crank shaft.

A pulley is fixed to the vertical crank shaft of the engine so that the driving power is transmitted from the pulley via a belt to a pulley fixed to the pump shaft 4 of the hydraulic pump P projecting upwards from the axle driving apparatus of the invention.

The tractor is provided at the front end or under the body with a mower R · R' to mow a lawn.

The invention relates to an axle driving apparatus for powering the axles 13 of the light tractor.

The following is a detailed explanation of the configuration of the axle driving apparatus with reference to FIG 2, FIG 3 and FIG 4.

The transmission casing of the axle driving apparatus is formed into upper and lower half casings 1 · 2 joined together to form a single sealed transmission casing.

The bearings for the axles 13 ·13 and the motor shaft 5 are interposed between the joined surfaces of the upper and lower half casings 1 · 2.

Once the oil passage plate 3 fixed to the hydraulic pump P and the hydraulic motor M has been mounted to the lower surface of the upper half casing 1, the lower half casing 2 is connected to the upper half casing 1 from below so that the lower half casing 2 is closed and bolts can be used to connect the upper and lower half casings 1 · 2.

The upper and lower half casings 1 · 2 are formed by aluminum die casting in which part of the casings is subjected to mechanical processing in order to lower manufacturing costs.

The HST transmission housed inside the axle driving apparatus of the invention comprises a hydraulic pump P, an oil passage plate 3, and a hydraulic motor. Here, the pump mounting surface 3d and the motor mounting surface 3e are situated perpendicular to each other on the oil passage plate 3.

A pair of crescent-shaped oil passages 3a' · 3b' is formed on the pump mounting surface 3d and a pair of crescent-shaped oil passages 3a" · 3b" is formed on the motor

mounting surface 3e, the pair of crescent-shaped oil passages 3a' · 3b' on the pump mounting surface 3d and the pair of crescent-shaped oil passages 3a" · 3b" on the motor mounting surface [3e] being connected directly to the oil passages 3a · 3b.

The cylinder block 10 of the hydraulic pump P is mounted so as to be able to rotate freely on the pump mounting surface 3d, and the pistons 12 are inserted so as to be able to reciprocate freely inside the piston holes in the cylinder block 10.

When the pump shaft 4 journalled on the upper half casing 1 and supported by the spherical bushing on the pump mounting surface 3d is rotated, the cylinder block 10 and the pistons 12 also rotate. The angle of the thrust bearing 15 abutting the upper end of each piston 12 is changed by a swash plate 9 so that the discharge rate and discharge direction of the hydraulic pump P are changed to supply the discharged hydraulic oil from the oil passages 3a' · 3b' in the oil passage plate 3 to the hydraulic motor M via the oil passages 3a · 3b.

The angle of the swash plate 9 can be changed by the rotation of the transmission lever shaft 6. A detent device 20 is formed in the neutral position of the transmission lever shaft 6.

As shown in FIG 2 and FIG 3, a short-circuit valve 25 with a sliding selector valve to short circuit the oil passages 3a · 3b on the discharge end and return end is situated so that the hydraulic motor M does not send hydraulic oil to the hydraulic pump P when the valve 25 is changed to generate hauling power for the tractor.

Here, 7 denotes the control used to operate the short-circuit valve 25.

The short-circuit valve 25 and the control 7 are pushed without being engaged so as to be able to control the apparatus during contact. This configuration allows the apparatus to be assembled more easily.

Check valves 26 · 27 are interposed between the oil passages 3a · 3b in the oil passage plate 3 to form an oil supply route 30, and an operating oil intake port 3c extends downward between the check valves 26 · 27.

An oil filter 8 made out of a spongy material is attached to the lower end of the operating oil intake port 3c. The bottom of the oil filter 8 comes into contact with the lower half casing 2 so as to be held in place.

The oil filter 8, operating oil intake port 3c and check valves 26 · 27 are situated so that there is communication inside the oil passages 3a · 3b via the check valves 26 · 27. As a result, negative pressure is generated in the oil passages 3a · 3b and the lubricating oil inside the casing is taken in as operating oil when the operating oil is low due to operation of the hydraulic motor M and the hydraulic pump P.

Here, O denotes the level of the lubricating oil in the transmission casing.

The flat portion of the pump mounting surface 3d for the oil passage plate 3 is somewhat larger than the flat portion of the mounting surface for the hydraulic pump P so that the oil passage plate 3 is attached to the bottom of the upper half casing 1.

The cylinder block 11 is attached to the motor mounting surface 3e at the oil passage plate 3 so as to rotate freely and so that the hydraulic fluid from the oil passages 3a · 3b applies pressure to the pistons 14. When the pistons 14 make contact with the thrust bearing 16, the cylinder block 11 and motor shaft 5 are rotated.

The motor shaft 5 is supported on the end with the oil passage plate 3 by a spherical bushing. It is supported by a spherical bushing on the other end as well. These are interposed between the upper and lower half casings 1 · 2.

A gear 17 is attached to the motor shaft 5. This gear 17 engages a gear 21 on the counter shaft 24.

A small-diameter gear 22 on the counter shaft 24 engages the ring gear 23 on the differential gear device D. The differential rotation of the differential gear device D provides power to the axles 13 · 13.

A brake drum 18 is fixed to the end of the motor shaft 5. The brake lever 19 opens the brake shoes outwards to make contact with the brake drum 18.

FIG 4 shows the portion of the motor mounting surface 3e that makes contact with the motor casing 11 for the hydraulic motor M.

FIG 5 and FIG 6 show another configuration for the oil passage plate 3.

In the case of oil passage plate 3', pump mounting surface 3d' and motor mounting surface 3e' are arranged in parallel fashion to the left and right, and the pump shaft 4 is used in tractors with the axles 13 · 13 extending in parallel fashion.

In the case of oil passage plate 3", the pump mounting surface 3d" extends to the front and rear while the motor mounting surface 3e" extends to the left and right. Here, an engine with a horizontal crank shaft is situated above the axles 13 · 13. This configuration is ideal for a belt drive.

By changing the configuration of the oil passage plate 3 in this manner, the direction of the pump shaft 4 can be changed.

(f) Effect of the Invention

The axle driving apparatus of the invention as configured above has the following effects.

First, the HST transmission device for driving the axles 13 is situated inside the casing formed by joining together the upper half casing 1 and the lower half casing 2, and the oil passage plate 3 connecting both oil passages is fixed to the mounting surface of the upper half casing 1 between the hydraulic pump P and the hydraulic motor M composing the HST transmission device. As a result, the HST transmission device does not require a casing because it is not situated to the outside of the axle driving apparatus casing as in the prior art. This allows for a smaller and lighter axle driving device.

Second, because an oil passage plate 3 joins the hydraulic pump P to the hydraulic motor M housed inside the casing of the axle driving apparatus, the axle driving apparatus can fit into the smallest of chassis, such as the chassis of a light tractor.

Third, because the motor shaft 5 of the hydraulic motor M is disposed parallel to the axle 13, the motor shaft 5 is journalled in the joined surface of the upper half casing 1 and the lower half casing 2, the pump shaft 4 of the hydraulic pump P is disposed vertically, the contact surfaces of the hydraulic pump P and the hydraulic motor M are disposed perpendicular to the oil passage plate 3, and the pump mounting surface 3d is the same as the mounting surface for the oil passage plate 3 on the upper half casing 1 as described in Claim 2, pulleys and belts can be used to simplify the transmission of power when used in a light tractor housing an engine E with a vertical crank shaft.

Also, the transmission of power from the motor shaft 5 to the axles can be simplified using gears and chains. As a result, the direction of the transmission of power does not have to be changed using the bevel gear device of the prior art.

Fourth, because two oil passages 3a · 3b connecting the hydraulic pump P to the hydraulic motor M are formed in the oil passage plate 3, two check valves 26 · 27 for supplying operating oil in the direction of the oil passages are disposed between the two oil passages 3a · 3b, an operating oil intake port 3c opened to below is opened between the check valves 26 · 27, and an oil filter 8 is attached to the bottom of the oil passage plate 3 as described in Claim 3, the lubricating oil inside the casing of the axle driving device can be used as the operating oil inside the HST transmission device. As a result,

the reserve tank of the prior art is not needed, and a low cost sponge material can be used as the oil filter 8.

4. Brief Explanation of the Drawings

FIG 1 is a side view of a light tractor provided with an axle driving apparatus of the invention. FIG 2 is a sectional rear view of the axle driving apparatus of the invention. FIG 3 is a sectional view taken from the line I-I in FIG 2 showing the state where the upper half casing is removed from the embodiment in FIG 1. FIG 4 is a plan view taken from the line II-II in FIG 2. FIG 5 and FIG 6 are perspective views of other configurations for the oil passage plate 3.

1 ... upper half casing

2 ... lower half casing

3 ... oil passage plate

3a, 3b ... oil passages

3c ... operating oil intake port

3d ...pump mounting surface

3e ...motor mounting surface

4 ... pump shaft

5 ... motor shaft

P ... hydraulic pump

M ... hydraulic motor

Applicant Kanzaki Kokyukoki Manufacturing Co., Ltd.

Agent Juichiro YANO, Patent Attorney

FIG 1

Agent Juichiro YANO, Patent Attorney

FIG 2

FIG 4

Agent Juichiro YANO, Patent Attorney

FIG 3

Agent Juichiro YANO, Patent Attorney

FIG 5

FIG 6

Agent Juichiro YANO, Patent Attorney